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## AGRICULTURAL SCIENCE AND THE PEOPLES' WELFARE *

DR. E. C. Auchter, who is research administrator to the United States Department of Agriculture, gave an address recently to the Second Inter-American Conference in Agriculture in which he pointed out some of the ways in which he thought agricultural science could be used to serve the welfare of the people of the world. In view of the great interest which is everywhere being taken these days on matters of public welfare and the general advancement of agriculture we quote below some of Dr. Auchter's remarks.

"Our duty", he says, "as agricultural scientists is threefold: first, to keep on everlastingly seeking for more of the truth, each of us in that field in which our particular work lies; second, to see to it that whatever truths we discover become as widely known as possible; and third, to advance the use of these truths for human well-being. Sometimes I think we are too modest about that second duty; we hesitate to talk about our discoveries lest it sound like boasting, with the result that they are sometimes neglected or forgotten and, like Mendelism, have to be rediscovered. And we are often too timid about the third duty. We feel that our job is to discover the facts and that the job ends there. Some scientists feel that they are not concerned, as scientists, with how, when or where the facts are applied. The result is that they may be misapplied, even completely distorted and science gets the blame. I do not say that we can entirely prevent this; I know we cannot, because all the scientists in the world are relatively a small handful of people. But we can *help* to prevent it by taking a much stronger, more positive interest in the use made of science by society."

"Our immediate concern, of course, is with the everyday problems that face us as agricultural scientists . . . Agricultural science is bound to find itself in a strengthened position as a result of recent events and there is no doubt to-day in anyone's mind about the need for science in agriculture. Vast armies have to be fed, clothed, housed and kept healthy. Our allies need enormous quantities of agricultural products. Our industrial workers must be well nourished to produce efficiently. The purchasing power of

*See *Science*, Vol. 96, No. 2491, pp. 283-289.

consumers has increased. Imports of critical commodities have been cut off; we must produce them in the Americas or create substitutes. And meanwhile there is a shortage of agricultural labour in the United States which must in part be made up by technical proficiency. None of these problems can be solved without making full use of all we know about scientific methods—and finding out as much more as we can as quickly as possible."

"Nor will the present emphasis on agricultural science end with the end of the war. We shall still have a very big job to do. Much of Europe is starving and in ruins. Asia, Africa, Australia have all suffered in greater or less degree from the blight of war. Immense areas and millions of people will need to be re-habilitated. To rebuild an exhausted world will necessitate making full use of agricultural science."

"At no time have we been faced by so great a challenge. To meet the situation adequately will require brains. The wisdom and foresight we apply to our work during the war and post-war period of world emergency will be influential not only in having the value of agricultural science fully recognised for a long time to come but in actually shaping the world."

Dr. Auchter then goes on to discuss some of the things which he considers we should do in conducting research to meet present needs and lay the foundations for a better future. The United States Department of Agriculture has recently, for example, been mainly concerned with a few urgent problems connected with the immediate needs of the war such as getting started on the production of Hevea rubber in South and Central America and of guayule rubber in the Americas, the speeding up of new ways of processing and packing foods to save shipping, the development in the Western Hemisphere of sources of important drugs, fibres and oils which were formerly received from the Orient. These are all jobs that have had to be done as quickly as possible. They have meant working under pressure, concentrating scattered research facilities and personnel on a single problem and reducing red tape to a minimum in order to get quick results. Here Dr. Auchter points out that there is need to make a critical study of research procedure to see whether we can do more "red tape cutting" and eliminate slow and cumbersome methods that have grown up as agricultural science became divided into more and more special compartments, and bring people together for quick, common action. There are, of course, many things that cannot be speeded up in scientific research but there are also places where Dr. Auchter thinks we can "strip down to a more clean cut basis that will enable us to proceed faster and more efficiently." This, he says, is the time to do it when there are so many urgent human welfare problems that face us. He also feels that, in so far as agricultural research in general is concerned, the research agency should carry along certain projects when it is convinced, after rigid self-examination, that they have an insurance value for the future, even though they may not have a popular appeal at the time. "The research worker must do more than follow the trends of current events; he also has a responsibility as a leader who looks ahead. Where scientific work is closely and directly tied up with the public welfare, as ours is, this responsibility is especially great. If we exercise it wisely, we can be sure of public approval in the long run."

Turning to the question of basic research Dr. Auchter says "Many people think of basic research as purely theoretical; they are unable to see, for instance, that it has any practical bearing on farm problems. Why spend time and money on it, they ask, especially in a critical period like this? To the scientist, the answer is simple: The whole progress of science depends on filling in the gaps in our knowledge of the nature of things. To the layman, however, it is not so obvious that much of the structure of modern science, with its vast number of practical applications in our daily lives is based on a comparatively few fundamental discoveries. In the case of basic research, we can seldom tell in advance what these practical applications will be; we simply know that we are on the trail of a fact which explains something not previously understood. But once the fact is established, the practical applications—sometimes very surprising ones—are likely to turn up in abundance." The following examples may be cited.

"It has been known for a long time, of course, that plants respond among other things to temperature and also to intensity of light. A few years ago it was discovered that they also respond to length of day. After this fundamental discovery was made, a good deal of experimental work was carried on to find out the nature of the responses, and many important facts were uncovered, the upshot of which is that the growth, flowering and fruiting characteristics of many plants—including many of economic importance in our agriculture—vary with variations in the length of the light period to which they are exposed. Originally this may have seemed like an interesting botanical fact not of great practical importance. But subsequent developments were to prove otherwise. Instead of expensive and lengthy field experiments, we can carry out comparatively inexpensive experiments in a greenhouse, under controlled light and other conditions, which show the range of adaptability of various kinds of plants; and on the basis of these experiments we can predict with considerable certainty what plants will do well in a given locality. If certain varieties of plants prove not to be well adapted to the day length and other conditions there, we can breed varieties of high quality and great uniformity that will be adapted . . . There are many other practical applications of this essentially *botanical* discovery about the nature of plants."

"The discovery of growth-regulating substances or hormones is another example of basic research that is now giving practical results . . . Another example is waxy corn which may briefly be mentioned. In the course of research on the genetics of corn, a plant was developed with a peculiar waxy quality in the starch of the endosperm. It was of no practical use whatever, but because of its theoretical interest it was not discarded but carried along by the breeders. Now this curious corn promises to be of great value as a substitute for tapioca starch, the supplies of which have been cut off by the war."

"The examples chosen have all come from the plant field, but similar ones could be given in practically every other field of agricultural science. . . . In the animal disease field, there is the discovery of phenothiazine as an anthelmintic and one of its remarkable characteristics is that it is effective for a considerable range of internal parasites in various classes of animals, whereas most anthelmintics are quite specific and limited in their usefulness. . . .In our modern insect control work, there is a background of studies in the life histories of insects to determine at what points each one is most vulnerable to attack, as well as detailed studies of the physiology and functioning of the insect organism, especially in relation to the effects of various poisons. In animal breeding, we are engaged in a major project to increase the production of our dairy herds by the widespread use of tested and proved sires. . . . Fundamental researches in the genesis of soils led to the development of ionic exchange or "base exchange." The practical results have been numerous and far reaching. We can now apply lime to acid soils accurately according to the needs of different crops and combinations of crops. Even more important, irrigation can be much better controlled. The formation of puddled alkali soils can be prevented and alkali soils reclaimed through chemical treatment and the control of irrigation water and drainage. . . . Finally in the field of nutrition there have of course been many interesting developments in recent years. . . ."

"In all these cases, either basic research precedes the practical applications of science, or a certain amount of this kind of research is found to be necessary somewhere along the line to clear up obscurities that block further progress. As public service agencies, agricultural research institutes exist primarily to help agriculture solve practical problems, but it should be remembered that there is no single road to practical results. If we keep our eyes constantly and exclusively on what seems to be immediate needs, we miss some of the richest fruits of scientific work—the fruits that grow from the discovery of important fundamental facts. . . ."

"In all research projects there should also be scientific freedom of inquiry. This freedom is denied whenever an effort is made to use science solely for the support and aggrandizement of a special group. In the long run this is a terrible mistake. Freedom to explain all kinds of facts wherever they may lead is absolutely necessary if science is to advance human welfare. It is a freedom well worth fighting for . . . ."

In his concluding remarks Dr. Auchter puts in a plea for closer co-operation between the several types of agricultural scientists. He says "Why not get the chemists, the bacteriologists, the entomologists and economists all together in the beginning and have them working simultaneously on parallel aspects of the problem, instead of end to end, separately and in sequence? In that way the job might be done in two or three years instead of ten. This is what we are doing now with more and more of our problems. The method is not new, of course, but its use is being accelerated by the conditions we all face to-day. We still have much to learn about this kind of integration, but as it is extended over larger areas of work, the possibilities seem stimulating and inspiring . . . ."

Finally, research workers are urged to become much more aware of the relation of their work to the problems of human welfare. "It is part of the business of agricultural scientists to try to understand and as far as possible anticipate human needs—both social and economic. To take an immediately pressing example—what is the world going to be like after the war? How can the enormous productiveness of science be put to work to make it a better world to live in than the one before the war? How can we direct our work as scientists to prevent wars and to create peace, plenty and opportunity for far more of the world's people? Those are the kinds of problems we must face in our thinking and planning. There is no question but that the view point and method of science can be a powerful factor in solving them."

## DEHYDRATION OF FOOD PRODUCTS IN CANADA

The results of work in Canada and England on the dehydration of food products, intensified on account of war conditions, has been pooled and tentative methods have been developed. Four vegetable products tested at Kentville, Nova Scotia, on a laboratory scale were potatoes, carrots, turnips and cabbage. Very high percentages of vitamin A, B and C were retained and palatability, structure and appearance of the refreshed product equalled that of freshly cooked vegetables. Five commercial plants are now being set up in Canada. Eight pounds of potato, 11 of carrot and turnip and 17 of cabbage make one lb. of their respective dried products. Under average conditions the product should store well for 2 years and withstand poor conditions for an appreciable time. Ten dehydrators are now operating their new methods in Canada in the case of fruit. Intensive research still continues on both vegetables and fruit drying.—(*Horticultural Abstracts;* XIII, No. 3, p. 169.)

# NOTES ON SOME DISEASES OF FIELD CROPS, VEGETABLES AND FRUITS AT THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

BY

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These notes are based on records of the diseases which occur on crops grown at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad as compiled by successive post-graduate plant pathologists mainly during the period 1939–1942. The writer is indebted to Messrs. R. K. McKee, D. Westwood, A. C. Trueblood and W. T. Dale for their contributions: also to Mr. C. A. Thorold, Plant Pathologist of the Trinidad Department of Agriculture and to the Agricultural Department, I.C.T.A. for help and advice. The majority of the records were made on the College farm, but diseases recorded in other experimental plots and gardens in the neighbourhood of St. Augustine are included. Observations were taken with regard to the intensity, extent of damage caused and the time when diseases were most prevalent, and it is felt that a summary of the records will be useful, especially in connection with those crops grown in Trinidad for food, the extension of the cultivation of which has become urgently necessary, owing to wartime conditions.

Many of the plants on the following list are grown on the College farm for demonstration only, and are not widely cultivated in Trinidad, whilst certain crops, such as citrus and cane, are dealt with rather summarily, as, although they are important and grown on a large scale in the island, they are cultivated only on a limited acreage at the College and hence a comprehensive study of their diseases has not been attempted. Diseases of crops at present only grown on an experimental scale and recorded as 'not serious' or 'causing little damage' might assume more serious proportions and require control methods if these crops were planted on a larger scale.

The crops are divided into Cereals, Sugar cane and fodder grasses, Root crops, Fruits and vegetables, Legumes, and Miscellaneous crops ; those which are important in the island either commercially or for food being indicated with an asterisk.

Whenever possible references to more detailed accounts of the symptoms and control of diseases are given. An account of many of them will be found in Nowell's (19) book, 'Diseases of Crop Plants in the Lesser Antilles'. This book is now unfortunately out of print as existing stocks were destroyed in London by enemy action.

Lists of fungous diseases occurring in Trinidad were made by Thorold (20) in 1931 and in Trinidad and the Caribbean region as a whole by the writer (3, 10) in 1937 and 1940.

Owing to the difficulty of obtaining spraying machines and fungicides, and to the writer's lack of confidence in this method of control of tropical fungous diseases except in certain well known instances such as banana leaf-spot and citrus scab, this method of control is not recommended in most cases. It will be found very often that by paying attention to cultivation, manuring, watering and drainage, and by not growing crops in unsuitable places or out of season, very many diseases can be avoided or at least their effects can be minimised.

Certain well-defined groups of diseases such as the wilt diseases and the *Cercospora* leaf-spots are merely listed under the crops which they attack, and are dealt with in more detail in separate sections towards the end of the paper.

## I. CEREALS

### Adlay (*Coix lachryma-jobi* Linn.) *

Adlay is a recent introduction into Trinidad and is not at present grown on a large scale. A demonstration plot sown late in 1941 was severely attacked by *Colletotrichum graminicolum* (Ces.) Wilson in January, 1942. This fungus attacks a number of grasses and cereals including Guinea corn, Guinea grass, and Sudan grass causing abundant small red-brown lesions on young and old leaves, which when severely attacked are liable to dry out and die prematurely. Diseases of this type can cause a reduction in the yield of a grain crop and considerable losses in fodder crops and are probably uncontrollable economically. When planted at the beginning of the rains in June, adlay grows rapidly and would be unlikely to suffer severely, but late-sown crops might be considerably affected.

### Maize (*Zea mays* Linn.) *

Maize is widely grown and is subject to many diseases, but under satisfactory cultural conditions few of them cause appreciable damage and no special control measures are necessary. Most of the diseases of maize have also been found on sweet corn, but not to any serious extent.

*1. Ustilago zeae* (Beckm.) Unger Smut

Maize smut can attack any young growing tissues but is most noticeable when it attacks the cobs. The grains are transformed into black masses of spores enclosed in a thin whitish membrane and are greatly enlarged so that they protrude from the sheathing bracts and are easily visible. Occasionally when a tassel is attacked it will produce seeds. Infected cobs are useless, but the disease is usually rare and sporadic, seldom attacking more than a fraction of one per cent. of a crop. Sweet corn is also attacked. This disease is not controllable by seed disinfection but is distributed with manure, compost or trash. Should it ever become troublesome the immediate removal and destruction of infected material should give adequate control.

2. *Puccinia purpurea* Cooke Rust

This or the allied species *Puccinia sorghi* Schw. is nearly always abundant on the older leaves of mature plants. It produces small orange-brown pustules on both sides of the leaf, but although abundant can seldom have any effect on the yield as the cobs are practically mature before it makes its appearance in any quantity.

3. *Helminthosporium turcicum* Pass. Leaf-blight

Causes large greyish-white elongated spots on the older leaves which are covered with the olive-green spores of the fungus. It is usually restricted to the older leaves in very wet weather and causes little damage.

4. *Cercospora sorghi* E. and E. Leaf-spot

Causes abundant small pale brown spots with a darker border on the older leaves, but although constantly present causes little or no damage.

5. *Phyllachora maydis* Maubl. Leaf-spot

Causes small lesions rather like tar-stains in appearance on the leaves. It occurred in November, 1939 and has been recorded on other occasions but is always rare and of no practical importance.

6. *Zea Virus* 1. Leaf-Stripe Disease

A virus disease which dwarfs the plants producing a bunchy-top effect and long white stripes on the leaves. Plants attacked young fail to develop and seldom even produce a tassel. This type of attack is rare and will seldom amount to more than one per cent. of the crop. Plants attacked at a later stage show a premature reddening and yellowing of the foliage and often produce poor cobs. Losses due to this phase of the disease are difficult to assess, but may be considerable, especially in dry weather. A fuller account of this disease has been given by Briton-Jones (12).

7. *Saccharum Virus* 1. Mosaic

Mosaic disease is very rare on maize in Trinidad and has not been recorded on the College farm for many years.

8. *Fusarium* sp. Wilt

An unidentified species caused a wilting and subsequent death of young plants in December, 1939. The vascular tissues of the plants were discoloured red, and red streaks were also visible on the leaves.

### Guinea Corn, Broom Corn, &c. (*Sorghum vulgare* Pers.)

Some of the diseases of maize also attack Guinea corn and have been recorded from time to time. Only *Colletotrichum graminicolum,* which occurs sporadically but is sometimes abundant is of any importance. As with adlay, leaf damage may sometimes be considerable. Other diseases recorded but of no economic importance are rust (*Puccinia purpurea* Cooke or P. *sorghi* Schw.), leaf-spot (*Cercospora sorghi* E. and E.) and the leaf-stripe virus.

### Rice (*Oryza sativa* Linn.) *

Few diseases have been recorded on rice in Trinidad and none of them occurs to any serious extent, with the possible exception of *Sclerotium oryzae.*

1. *Tilletia horrida* Tak. Bunt

Bunt is nearly always present but never causes more than a few diseased grains in a panicle. It is often so rare that it is difficult to find at all and causes no appreciable damage. Diseased grains can usually be recognised by their darker colour and by a powdering of black spores on the glumes.

2. *Helminthosporium oryzae* B. de H. Brown spot

Causes longitudinally elongated reddish spots, which later become pale and dry out, on the leaves. It is usually very abundant on old plants just before harvest, but the damage caused is negligible.

3. *Sclerotium oryzae* Catt. Wilt

*Sclerotium oryzae* is regarded by some authors (22) as another stage in the life cycle of *Helminthosporium oryzae,* and the Ascomycete *Leptosphaeria salvinii* Catt. has been described as the perfect stage of both. In Trinidad, however, this relationship has not been established and the two diseases will be considered separately.

*Sclerotium oryzae* causes plants of any age to wilt and die. Diseased plants can usually be recognised in the field as being somewhat dwarfed and producing late tillers ; they later turn brown and wilt. Some diseased plants will produce a few panicles, but the grains are usually light and useless. On splitting the plant a dark greyish weft of hyphae and sclerotia about pin-head size can be seen inside the leaf-sheaths and hollow stem. It is not known how much damage this disease causes in Trinidad, but in the St. Augustine rice-growing area losses due to it are inconsiderable. Sclerotial diseases are as a rule difficult to eradicate from the soil, but if this disease became troublesome a hot weather bare fallow might prove effective.

## II. SUGAR CANE AND FODDER GRASSES

### Sugar Cane (*Saccharum officinarum* Linn.) *

When compared with the insect pests of sugar cane in Trinidad the diseases are of very minor importance. Of the two important diseases of cane in the West Indies, *Bacterium vascularum* Cobb (Gumming disease) and *Saccharum Virus* 1, (Mosaic disease) the former is absent from Trinidad and latter so rare that it is of negligible importance and has never been recorded at the College.

1. *Leptosphaeria sacchari* B. de H. Ring-spot

Causes small purple spots which dry out and become grey in the centre. It is often very common on the older leaves of both plant and ratoon canes but causes little damage.

2. *Colletotrichum falcatum* Went Red rot

The primary symptoms (caused by the use of diseased planting material) consisting of yellowing and wilting and finally death of whole stools were recorded in November, 1940 on a few plants. Attacks of this kind are rare on the College farm, but the secondary symptoms consisting of the reddening of the tissues of one or two internodes followed only by the death of individual canes occur more frequently. In controlling this disease it is very important that clean planting material should be used and any setts showing reddening should be rejected. This is a safety measure as all reddening of sugar cane is not due to 'red-rot'. Reddening of cane is merely a wound response and will be found in canes damaged by insects or in any other fashion, but may be taken as indicative of setts which are liable to rot in the ground or give poor germination.

**Elephant Grass** (*Pennisetum purpureum* **Schum.**)

*Helminthosporium* (? *ocellum* Faris) Leaf-spot

The spots are purplish at first later drying out and becoming light brown and covered with the olive-green conidia of the fungus. They are elongated parallel to the veins of the leaf and when numerous they coalesce causing considerable destruction of foliage. This fungus occurs sporadically at intervals of several years and formerly assumed epidemic proportions, practically wiping out whole fields of elephant grass. A resistant strain of elephant grass, known as the Uganda variety, is now cultivated on the College farm and as a result no epidemic outbreak has been recorded for several years. The fungus still appears every year on the resistant strain but causes no damage. A similar destructive disease is attributed to *Helminthosporium ocellum* Faris in Florida (23) and also in Hawaii (17).

**Guatemala Grass** (*Tripsacum laxum* **Nash**)

*Puccinia polysora* Underw. Rust

The orange-brown pustules of this fungus are always present on the older leaves, often in considerable quantity. Plants are however, seldom seriously damaged as it chiefly attacks the older leaves. Damage caused by this disease is more apparent in the dry than in the wet season ; it is also noticeable when the grass has been cut at too frequent intervals leading to loss of vigour. Although Guatemala grass has been grown for some years at the College, this disease was recorded for the first time in 1937, but it had apparently been present elsewhere in the colony for a longer period. It is often accompanied by a hyperparasitic *Darluca* species.

**Guinea Grass** (*Panicum maximum* **Jacq.**)

*Colletotrichum graminicolum* Leaf-spot

See under adlay for a fuller account. Apart from killing the older leaves of Guinea grass it does not do much damage.

**Sudan grass** (*Sorghum sudanense Stapf.*)

*Colletotrichum graminicolum.* Leaf-spot

See under adlay for a fuller account. The symptoms are the same but the disease is not confined to the older leaves and considerable damage is caused. This disease is probably sufficiently severe to prevent the successful use of Sudan grass as a fodder crop in Trinidad.

Little or nothing can be done to control the diseases of fodder grasses. Spraying would prove neither practicable nor economic, and little can be done to modify cultural methods. The result is that any serious disease, even though it may only occur sporadically, may render a promising grass useless as a farm crop.

## III. ROOT CROPS

**Cassava** (*Manihot utilissima* **Pohl.**) *

Cassava remains remarkably free from disease in Trinidad, and only two minor leaf diseases have been recorded from the College farm. Cassava mosaic, which is a very serious disease in many countries, although frequently suspected, apparently does not occur in the island, the symptoms most commonly mistaken for it being caused by mites.

1. *Cercospora henningsii* Allesch. Leaf spot

The spots are about a quarter of an inch in diameter and appear first as darker water-soaked areas on the leaves, but rapidly turn brown and dry out. They occur mainly on the older leaves and never cause any serious damage.

2. *Uromyces janiphae* (Wint.) Arthur Rust

The pustules are brown in colour and are surrounded by light coloured areas on the leaves. This disease is always very rare at the College.

3. *Botryodiplodia theobromae* Pat.

Caused a blackish rot of stored roots in June, 1940. As a rule however, cassava roots are not stored except for experimental purposes, being better left in the ground until required.

**Sweet Potato** (*Ipomoea batatas* (**Linn.**) **Lam.**)*

As with sugar cane the comparative absence of serious fungous diseases is more than counterbalanced by the numerous and serious insect pests. Only two leaf diseases of minor importance have been recorded on the College farm. Storage rots are however, much more troublesome and even with the most careful handling tubers cannot be stored for more than two or three months without serious losses.

1. *Cystopus ipomoeae-panduranae* Farl. White Rust

Causes white waxy spots on the leaves and stems accompanied by considerable distortion. Although it is usually present it does not cause any appreciable damage and no control measures are necessary.

2. *Phyllosticta batatas* (Thum.) Cooke.

Causes small circular brown spots dotted with the black pycnidia of the fungus on the leaves. Spots are seldom numerous and the disease is of no economic significance.

**Yam** (*Dioscorea alata* **Linn.**) *

Like cassava and sweet potato, yams are almost free from fungous diseases in Trinidad. In addition, provided that great care is taken when the tubers are lifted, and provided that they are stored under good conditions in shallow layers, the tubers can be kept for long periods without serious losses from storage rots.

*1. Cercospora nubilosa* E. and E. Leaf spot

Causes large dark brown or black lesions on the leaves, but mainly on the older or senescent ones. These spots are usually rare until the crop is almost ready for harvest and damage is negligible. Plants severely attacked at an earlier stage are almost certainly growing poorly owing to lack of manure or bad cultivation.

*2.* Species of *Colletotrichum* and *Macrophoma* have also been found on large brown lesions, but their parasitism has not been established.

*3.* 'Dry-rot'.

Every year a certain number of tubers are lost in storage on the College farm from a 'dry-rot', the cause of which has not at present been ascertained. The yam eel-worm, which causes serious losses of stored yams in West Africa, has never been recorded.

**Tous-les-Mois** (*Canna edulis* **Ker.-Gawl.**)

*Puccinia cannae* (Wint.) P. Henn. Rust

The yellow-brown pustules of this disease are very common on garden cannas, but there is some doubt whether *Canna edulis* is attacked. The evidence indicates that it is far more resistant and that attacks are at most sporadic.

## IV. LEGUMES

Most of the legumes are attacked by species of *Cercospora* which typically produce small brown lesions on the leaves. These lesions usually dry out until they are almost white and fall away to leave 'shot-holes'. When the spots become numerous they coalesce killing the leaves and causing appreciable damage. Each spot is the result of a separate infection.

Virus diseases of the mosaic type are also common and are believed to be seed-borne, but this requires confirmation.

**Cluster Bean** (*Cyamopsis psoraloides* **DC.**)

*Cercospora* sp. Leaf-spot

Causes irregular brown spots surrounded by a halo of yellowing tissue, which coalesce and produce dried out areas causing some damage.

**Lima Bean** (*Phaseolus lunatus* **Linn.** )*

*Cercospora canescens* E. and M. Leaf-spot

Causes small brown, circular lesions which later dry out. They are usually confined to the older leaves, but may be very common and cause some damage.

**Bonavist Bean** (*Dolichos lablab* **Linn.**) *

*Cercospora dolichi* E. and E. Leaf-spot

Causes numerous irregular brown spots usually confined to the older leaves. The control of diseases of this type is not a practical proposition, and in any case would not be likely to repay the initial outlay. Healthy crops are seldom seriously attacked.

**Soy Bean** (*Glycine max* (**Linn.**) **Merr.**) *

*1. Cercospora* sp. Leaf-spot

Causes irregular brown lesions which do not dry out completely for some time. It is of no great importance as, although it may be abundant, it is usually only found on plants which have already ripened most of their crop.

*2. Mosaic*

A virus disease, thought not to be the true soy bean mosaic *Soja Virus* 1, is seen occasionally. Legume mosaics are probably all seed-borne to some extent, but are all readily and widely spread by their insect vectors from infected crops and probably from natural reservoirs of disease. For this reason it is by no means certain that the provision of a disease-free seed supply would give a satisfactory control. Control might be both practical and profitable through the control of insect pests in general.

**Cowpea** ( *Vigna unguiculata* (**Linn.**) **Walp.** *

*1. Cercospora cruenta* Sacc. Leaf-spot

Circular brown spots up to half an inch in diameter caused by this fungus are usually present on the older leaves, but are of no importance.

*2. Mosaic*

A virus disease with typical mosaic symptoms is very common. Damage varies, but may be considerable. Like other mosaics of the Leguminosae it may be seed-borne, but is always widely spread by its insect vectors.

**String and Dwarf Beans** (*Phaseolus vulgaris* **Linn.**)*

*1. Bacterium phaseoli* Smith

Causes water-soaked areas on the pods. These bacterial lesions are rapidly followed by secondary fungi and the pods are destroyed. This disease has only been recorded once and was not serious.

*2. Phaseolus Virus* 1. Mosaic

Susceptible varieties show stunting of the plants and distortion and mottling of the leaves. This disease also may be seed-borne.

*3. Botrytis* sp. Leaf-blight

In wet weather the leaves of certain climbing varieties such as Kentucky Wonder may be rapidly destroyed by a fungus apparently belonging to the genus *Botrytis*. Large water-soaked irregularly zoned areas appear on the leaves which rapidly turn brown and collapse. A similar disease has been noted on lettuces and Chinese cabbage (Var. Patchoi). Spores of the *Botrytis* type were found on beans in 1941 and

an identical rapidly growing fungus forming sclerotia in culture was isolated from beans, lettuces and Chinese cabbage in 1942. Although locally severe this disease clears up as soon as the weather improves and so far no control methods have been suggested.

**Groundnut** (*Arachis hypogaea* **Linn.**)

*1. Cercospora personata* B. and C. Leaf-spot

Characterised by small circular black spots on the leaves. It is usually quite common but probably results merely in the earlier shedding of senescent leaves.

*2. Puccinia arachidis* Speg. Rust

The orange-brown pustules of this disease are usually present but not to any serious extent. In February 1941 however, severe leaf damage was caused to mature plants and the yield was probably reduced.

**Pigeon pea** (*Cajanus cajan* (**Linn.**)) **Millsp.** *

*1. Uromyces dolicholi* Arthur Rust

The dark brown pustules are found on the undersides of the leaves and have corresponding yellow patches on the upper sides. It may be common on all the leaves including the youngest, but does not appear to cause serious damage and seldom attacks young plants.

*2. Physalospora* sp. Canker

Every year canker causes the death of a certain number of plants and in February and March, 1940 it was severe. On this occasion almost all the plants showed some cankers and many were killed by girdling of the collar. This is the most serious disease of pigeon peas in Trinidad, attacking and killing the plants as they come to maturity. The cankers can usually be seen as dead areas speckled with the pycnidia and perithecia of the fungus on the bottom foot or two of the main stem. No satisfactory control measures are known. This disease is discussed in detail by Leach and Wright (16).

*3. Cercospora cajani* P. Henn. Leaf-spot

The lesions of this fungus are almost always present on the older leaves but cause little damage.

*4. Phoma* sp.

Brown spots often causing a distortion of the leaf tip appear to be constantly associated with a *Phoma* species. Pycnidia are visible on these lesions as small black dots. Damage is slight.

*5. Fusarium* sp. Wilt

A fungus of this genus was isolated from wilted seedlings in 1942. For further information see section on wilt diseases.

**Sword Bean** (*Canavalia plagiosperma* **Piper** and *C. ensiformis* **DC.**)

*Cercospora canavaliae* Syd. Leaf-spot

Causes small lesions visible on the upper sides of the leaves as dark brown rings with dried out centres. On the under side are abundant olive-brown conidiophores. It is usually present but never very serious.

**Bengal Bean** (*Mucuna aterrima* **Holland**)

*Cercospora stizolobii* Syd. Leaf-spot

The small brown lesions occur very commonly on the older leaves but cause little damage.

**Sunn Hemp** (*Crotalaria juncea* **Linn.**) *

*Fusarium* sp. Wilt

Local Sunn hemp is exceedingly susceptible to *Fusarium* wilt but a resistant strain recently introduced from India is giving very promising results.

**Woolly Pyrol** (*Phaseolus mungo* **Linn.**) *

*1. Erysiphe (? polygoni* DC.) Mildew

The conidial stage of a mildew possibly of this species was found at the end of the dry season in 1940. It is not common and requires some searching for but can generally be found on crops of woolly pyrol grown in dry weather. The mycelium is sparse and dark blue or grey in colour. Damage is negligible.

*2. Mosaic.* Virus

An occasional mosaic-like mottling of the leaves presumed to be of virus origin was noted in 1942.

(*To be continued*)

## EFFECTS OF WEEDS ON GROWTH OF SUGAR CANE

According to the *Report of the 61st Annual Meeting of the Hawaiian Sugar Planters' Association* (1941), it had been previously shown that heavy losses of dry matter in plant cane were produced by allowing weeds to develop during the first six weeks. It has now been shown that, provided weeds are controlled during that period, later weed growth has a less marked effect. When controlled during 12 weeks in all, weed growth had but little effect upon yields; otherwise the loss was more or less proportionate to the cane's growth stage when the weed crop started.

At two centres no depression in cane yields at 15 and 22 months was produced when the final weed-controlled operation—ordinarily considered essential—was omitted, though in one case there had been a very heavy weed crop at three months. In both cases the initial early crop of weeds had been brought under control. At another centre the values of thorough weeding were claimed to be demonstrated: the yields were reduced if a heavy weed growth was allowed to persist while the cane was between 1½ and 4 months old. At another centre where partial weed control in third ratoon cane had seemed inadequate the final result was that less cane was harvested, but of better quality, and hence the same amount of sugar was obtained as from plots on which weed control costing three times as much had been practised. In view of these results further work on the weed problem appears necessary.

# GRAFTING EXPERIMENTS WITH COTTON

BY

S. G. STEPHENS

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## Introduction

A MAJOR difficulty in carrying out experimental work with cotton in a humid climate is the storage of seed. It has been found more satisfactory here to maintain all material, other than that required for immediate genetic study, by grafting. In 1939 two experiments were carried out to test the relative suitabilities of various types as stocks. It is felt that the results obtained may be of a more general interest than their immediate practical bearing since they throw light on certain general principles underlying stock/scion interactions and suggest lines of more critical and comprehensive research.

One experiment was designed on a field scale ; its object being to compare the growth rates, earliness of flowering, types of bolling curve, and yields of selected scions on a range of stocks. The other was carried out on a small scale, the plants being grown in large buckets. It was designed to measure the mutual interaction of stock and scion in two varieties, as shown by rate of growth of scion and rootstock. In both experiments the method of grafting employed was the 'approach' or 'bottle'-graft (Harland, 1927).

## Field Experiment

### (I) MATERIALS AND METHODS

The stocks and scions which were employed in all possible (15) combinations are shown in Table I.

The plants were spaced at 4 ft. × 4 ft. and each sub-plot contained five plants. A single discard row of V 135 surrounded each plot.

The three scions were arranged in a 3 × 3 Latin Square. Each of the nine main plots was then split into five randomised sub-plots corresponding with the five stocks. The variance in each character could then be analysed in the following way:—

| | | D.F. |
|---|---|---|
| *Between main plots* | Rows | 2 |
| | Columns | 2 |
| | Scions | 2 |
| | Error (a) | 2 |
| | | 8 |
| *Within main plots* | Stocks | 4 |
| | Scions × Stocks | 8 |
| | Error (b) | 24 |
| | | 36 |
| | Total | 44 |

### (II) EARLY GROWTH OF SCION

A month after grafting it was obvious that the most rapid growth was made by scions grafted on Triumph stocks and the slowest on N 14 stocks. Two months after grafting the number of internodes formed on the main stem of each scion was counted and the average internode length estimated. Analyses of variance showed no significant stock/scion interactions and the pooled data for the three scions are given in Table II. Although the effects of stocks on number of internodes formed were not quite parallel with their effects on internode length, there was a marked tendency for early scion growth to be most vigorous on the

**Table I**

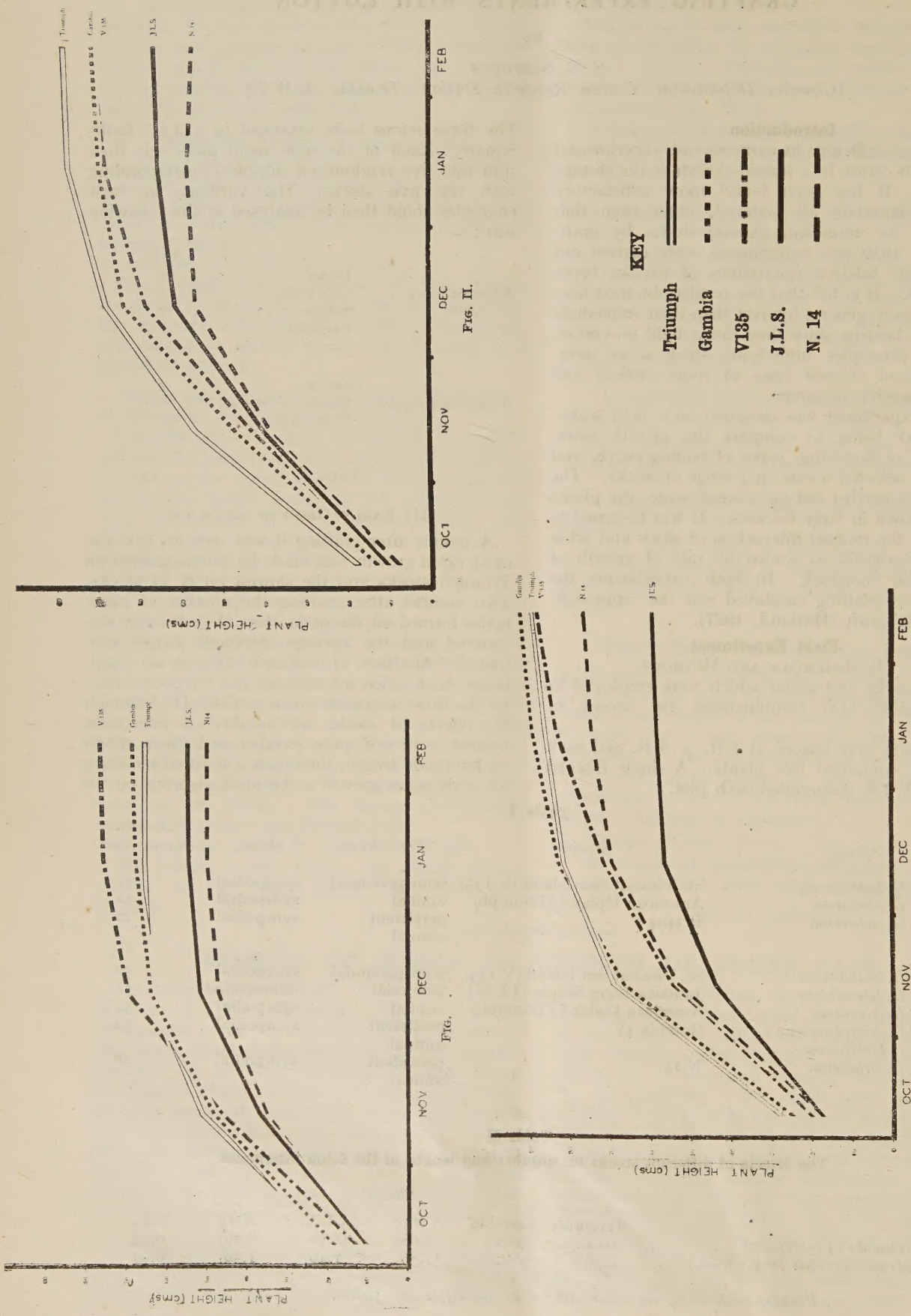
| | *Species* | *Strain* | *Persistency* | *Habit* | *Somatic chromosome no.* |
|---|---|---|---|---|---|
| *Scions* | *G. barbadense* | St. Vincent Sea Island (V 135) | semi-perennial | sympodial | 52 |
| | *G. hirsutum* | American Upland (Triumph) | annual | sympodial | 52 |
| | *G. arboreum* | P 3494 s | persistent annual | sympodial | 26 |
| *Stocks* | *G. barbadense* | St. Vincent Sea Island (V 135) | semi-perennial | sympodial | 52 |
| | *G. barbadense* | Jamaica Long Staple (J.L.S.) | perennial | monopodial | 52 |
| | *G. hirsutum* | American Upland (Triumph) | annual | sympodial | 52 |
| | *G. hirsutum* var *punctatum* | Gambia 4V | persistent annual | sympodial | 52 |
| | *G. arboreum* | N 14 | persistent annual | sympodial | 26 |

**Table II**

**The effects of different stocks on number and length of the scion internodes**

| | *Stocks* | | | | | |
|---|---|---|---|---|---|---|
| | Triumph | Gambia | V 135 | J.L.S. | N 14 | S.E. |
| *Number of internodes* ... | (10.10) | (9.02 | 8.98) | (8.10 | 8.29) | 0.22 |
| *Mean internode length (cms.)* | (1.76 | 1.82) | (1.56 | 1.40 | 1.39) | 0.07 |

*Figures enclosed by the same bracket do not differ significantly*




Figs. I—III. The effect of five different stocks on the growth (increase in plant height) of I—Triumph (Upland) scion. II—V135 (Sea Island) scion. III—P3494s (Asiatic) scion.

annual Triumph and Gambia stocks and least vigorous on the perennial Jamaica Long Staple stock. Growth on the N 14 stock was about equal to that on Jamaica Long Staple.

Before considering the significance of stock effects it is necessary to have clearly in mind the habit and growth characteristics of the types used as stocks. Triumph is characterised by rapid growth over a short period of time, V 135 by growth which is less rapid but maintained for a longer period, while Jamaica Long Staple does not attain its maximum growth activity during the first season. Gambia is intermediate between Triumph and V 135 but resembles the former rather than the latter variety. Asiatic types as a whole are less well adapted to Trinidad conditions and their growth is never as vigorous as that of New World types of equivalent habit. It may be concluded therefore from the data in Table II that the early growth of the scions reflected the habit and growth characteristics of the stocks on which they were grafted.

Earliness of flowering was also found to be affected significantly by the stocks employed. At first it was thought that variations in number and length of internodes and earliness of flowering might be expressions of the same phenomenon *viz.* a general acceleration of growth induced by certain stocks. Such a simple interpretation could not be confirmed however. Analyses of covariance revealed no association between the three characters, and furthermore earliness of flowering was affected by significant stock/scion interactions, although no such interactions were found to affect internode number or internode length.*

### (III) Plant Height

At monthly intervals throughout the season, plant height was measured. Except at the last measurement there were significant stock/scion interactions, so that in assessing stock effects scions were considered separately. Curves illustrating growth in plant height are shown in Figs. I–III.

The reactions of the three scions to Triumph, Gambia and V 135 stocks were essentially similar. In the earlier stages growth was more rapid on the Triumph (annual) stock, but later there was a tendency for this stock to be surpassed by Gambia (persistent annual) which in turn tended eventually to be outstripped by V 135 (semi-perennial). The stage at which the annual stock was surpassed by the more perennial ones depended, however, on the nature of the scion. In the case of the rapidly growing Triumph scion (Fig. I) the order of the three stocks at the first measurement was completely reversed at the end of the season. In the case of the P 3494 s scion (persistent annual) the Triumph stock was surpassed by the Gambia stock but only equalled by the V 135 stock at the last measurement (Fig. III). In the case of the V 135 scion (semi-perennial) the Triumph stock maintained its lead throughout, but the Gambia stock was eventually equalled by V 135 (Fig. II).

Growth of all three scions on Jamaica Long Staple and N 14 stocks was inferior. It seems likely that the inferiority was due to independent underlying causes. The slow growth of a perennial type in its first season offers an adequate explanation of the poorness of Jamaica Long Staple as a stock. The general inferiority of Asiatic to New World types probably accounts for the relatively poor growth on the N 14 stock. A particularly interesting feature is the marked stock/scion interaction with regard to these stocks. The New World scions (Figs. I and II) grew more rapidly on the Jamaica Long Staple than on the N 14 while the Asiatic scion (Fig. III) grew more rapidly on the Asiatic (N 14) stock.

### (IV) Bolling

Bolls were picked at ten-day intervals and the numbers collected were recorded and plotted to form bolling curves (Figs. IV to VI). All scions agree in showing two flushes of boll formation. Bolling curves, like measurements of plant height, showed that Triumph, Gambia and V 135 were the best stocks, and that their habit characteristics were reflected in scion behaviour. The effect of stock habit was shown most clearly by the Triumph scion. On Triumph and Gambia stocks this scion produced its maximum number of bolls during the first flush, and the second flush was relatively unimportant. On the V 135 stock maximum boll production was delayed until the second flush (Fig. IV). There was about six weeks difference in time of maximum boll production between scions on *hirsutum* and on V 135 stocks.

V 135 scions showed less difference in reaction to the three stocks. In all cases the second flush of boll production was by far the more important, as expected in the case of a semi-perennial scion. However, the first flush was noticeably more important on Triumph and Gambia than on the V 135 stock (Fig. V).

Boll production of the Asiatic scion (Fig. VI) reached its maximum at the first flush and differences in reaction to Triumph, Gambia and V 135 stocks were not marked.

It has been seen in considering the effects of different stocks on plant height that in addition to the stock/scion habit interactions of the New World types, there was an interspecific interaction involving the two poorest stocks, Jamaica Long Staple and N 14. A similar tendency is shown by the bolling data. The New World scion showed poor boll production on both stocks, with N 14 tending to give a better first, and Jamaica Long Staple a better second flush. The Asiatic scion showed a markedly better boll production on N 14,

*Crowther (1934) in analysing factors affecting growth of the cotton plant concluded that number of internodes and length of internodes were controlled by nitrogen and water supply respectively. Flower production was affected by interactions between nitrogen and water supply. It seems likely therefore that in the present case stock/scion unions exerted differential controls over nitrogen and water uptake by the scion.

and in fact not significantly inferior to its bolling on the *hirsutum* and V 135 stocks. The interaction is more easily appreciated from the data given in Table III.

### (V) Yield

A direct comparison of yielding ability was not practicable because owing to unusually dry conditions during the later stages of growth, the later formed bolls failed to mature properly. The yields of the early maturing varieties were therefore unduly favoured. Two estimates of potential yielding ability were available: number of bolls produced (including immature bolls) and weight of seed cotton per boll (based on the weight produced during the first flush of boll production only). These are summarised in Table III. Analyses of variance of both number of bolls produced and weight of seed cotton per boll revealed significant differences between stocks and significant stock/scion interactions.

Table III shows that while number of bolls and weight of seed cotton per boll produced by the Asiatic scion were only appreciably restricted by the Jamaica Long Staple stock; the New World scions, in general, were restricted both by Jamaica Long Staple and N 14 stocks. The yield of the V 135 scion was definitely better on the former than on the latter stock, but in the case of the Triumph scion there was little to choose between them. This difference between the New World scions in reaction to the same stocks is understandable from Figs. IV and V. The superiority of the Jamaica Long Staple over the N 14 stock is only asserted at the second flush of bolling which makes a more important contribution to the whole season's yield in the case of the V 135 scion (Fig. V) than in the case of the Triumph scion (Fig. IV). In short, a stock/scion habit interaction is involved. However, a similar habit interaction between stock and scion is not adequate to explain the different reaction to stocks exhibited by Triumph and Asiatic scions since both are annual types having, normally, poor second flushes of bolling (Figs. IV and VI). A preference of Asiatic scion for Asiatic stock, and of New World scion for New World stock would appear to be acting independently of stock/scion habit interactions.

The three most vigorous stocks, Gambia, Triumph and V 135 may next be considered. Table III shows that in comparison with Gambia the Triumph stock had an all round restricting effect on the yield of all three scions. Replacing the Triumph by the Gambia stock resulted in increased number of bolls per plant and increased seed cotton per boll. This effect is not seen in comparing the Gambia with the V 135 stock. P 3494 s and V 135 scions produced more bolls on Gambia than on V 135 stocks but the increase was partly offset by a decrease in weight of seed cotton per boll. A similar compensatory effect is seen in the case of the Triumph scion, but here the greater boll production on the V 135 stock was partly offset by the larger bolls on the Gambia stock. It is evident that scions on Gambia and V 135 stocks were approaching a 'yield ceiling' *i.e.* a level of vigour where the yield components (number and size of bolls) were no longer independent.

There was an interesting interaction between Triumph and V 135 stocks and scions. Triumph scions on V 135 stocks and V 135 scions on Triumph stocks produced more bolls than when grafted on their own stocks. The reason is clear when the bolling curves in Figs. IV and V are examined. V 135 stocks prolonged the bolling period of the normally early bolling Triumph scion by producing a second flush. On the other hand Triumph stocks tended to increase the first flush of the normally late bolling V 135 scion. An effect analogous to hybrid vigour was thus produced.

**Table III**

**The effects of stocks on scion yields**

| | *Stock* | *Mean no. of bolls per plot* | *Mean weight of seed cotton per boll (gms.)* | *Mean potential yield per plot (gms.)* |
|---|---|---|---|---|
| *Triumph* | V 135 | 57.7 | 2.45 | 141.37 |
| | Gambia | 41.3 | 3.28 | 135.46 |
| *Scion* | Triumph | 35.0 | 2.77 | 96.95 |
| | J.L.S. | 24.7 | 2.02 | 49.89 |
| | N 14 | 22.0 | 2.27 | 49.94 |
| *V 135* | Gambia | 112.3 | 1.82 | 204.39 |
| | Triumph | 104.3 | 1.72 | 179.40 |
| *Scion* | V 135 | 90.3 | 2.12 | 191.44 |
| | J.L.S. | 51.0 | 1.76 | 89.76 |
| | N 14 | 38.0 | 1.41 | 53.58 |
| *P 3494 s* | Gambia | 39.3 | 1.90 | 74.67 |
| | Triumph | 37.3 | 1.59 | 59.31 |
| *Scion* | N 14 | 32.7 | 1.57 | 51.34 |
| | V 135 | 32.3 | 1.79 | 57.82 |
| | J.L.S. | 17.3 | 1.37 | 23.70 |
| *Standard error of mean* | | 5.7 | 0.10 | — |

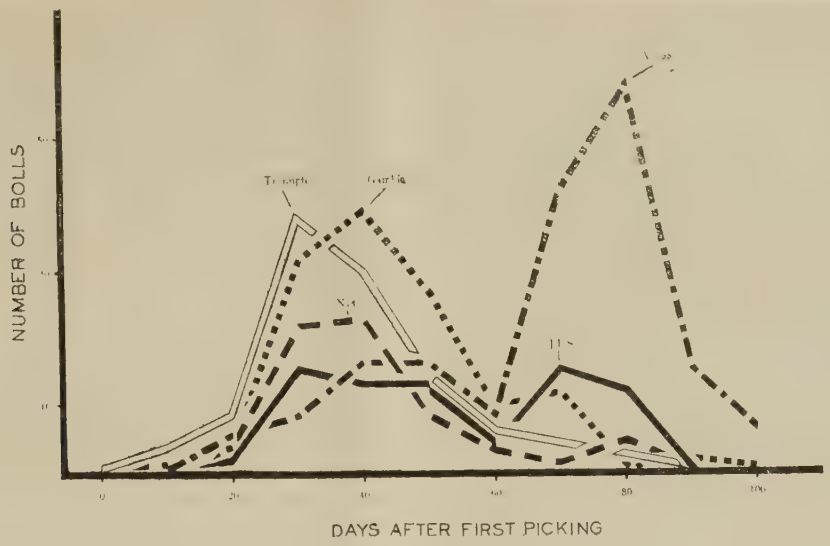



FIG. IV.

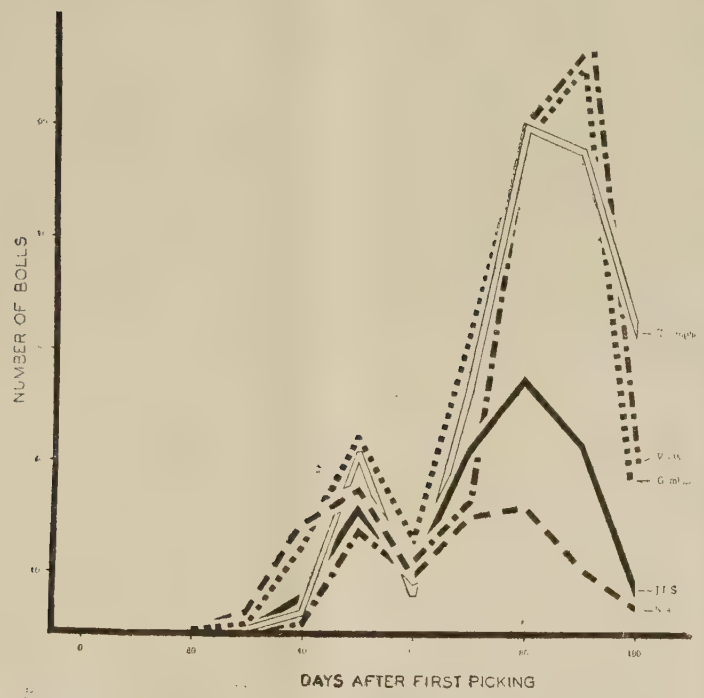



FIG. V.

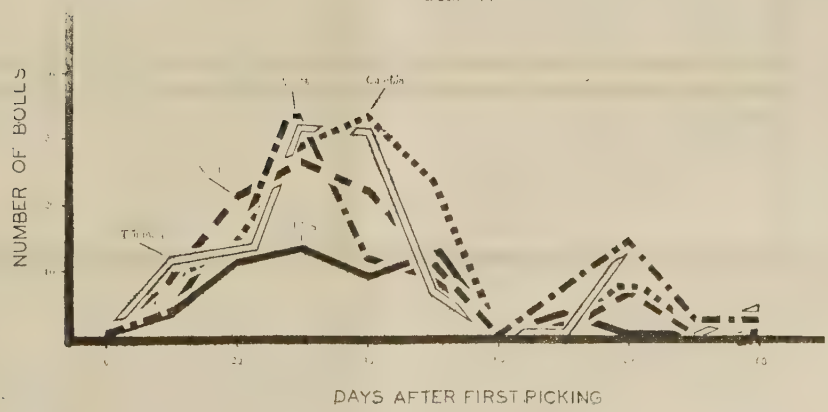



FIG. VI.

FIGS. IV—VI.—The effect of five different stocks on the bolling curve of IV—Triumph (Upland) scion V—V 135 (Sea Island) scion. VI—P3494s (Asiatic) scion. For Key see page 34.

### Small Scale Experiment

This experiment was confined to the two varieties Triumph and V 135. Reciprocal grafting was carried out, so that there were four types for examination. The plants were grown in large buckets, the four types being randomised for position and replicated ten times. Examinations were carried out at two stages: (1) three months after grafting, (2) four months after grafting. At the first examination plant height was recorded and then five plants of each type (half the total number of plants) were carefully removed from their buckets and their root systems washed, air-dried and weighed. At the second examination plant height and root weight were estimated from the remaining plants. The results are presented in diagram form (Fig. VII).

Perhaps the most striking effect of reciprocal grafting is that at both the first and second sampling, size of root tends to be determined by the scion grafted upon it, and independent of its own specific origin. Thus there are much greater differences in respect of root size between scions than between stocks. Secondly, considering only the 'all V 135' and 'all Triumph' combinations, it is evident that at both samplings the shoot/root ratio is about twice as large in the *hirsutum* as in the *barbadense* variety. It would be interesting to know whether this difference is connected with specific or habit differences. Although the shoot/root ratios of the two varieties remain in fairly constant proportion to each other, the ratios themselves are halved between the times of first and second samplings. In both varieties therefore root growth accelerates in relation to shoot growth.

The altered growth rates of the 'cross-grafted' types illustrated in Fig. VII become simplified on the hypothesis that the relative growth rates of stock and scion become adjusted in such a way that the normal shoot/root ratio of the species providing the scion tends to be restored. On this hypothesis the following adjustments might be expected:—

(*i*) *V 135 scion on Triumph stock.* Since the Triumph shoot/root ratio is greater than that of V 135, transference of Triumph stock to V 135 scion should produce increased root growth as compared with the root growth of the 'all Triumph' combination. At the time of the second sampling this increase in root growth had not equalled that of the V 135 standard, so that the V 135 scion growth was also restricted. These expected adjustments are realised in Fig. VII.

(*ii*) *Triumph scion on V 135 stock.* Transference of V 135 stock to Triumph scion should produce decreased rate of root growth as compared with the root growth of the 'all V 135' combination. This is realised in Fig. VII. At the time of the second sampling the root size was not significantly greater than that of the 'all Triumph' combination. It would be expected therefore that the scions of the 'all Triumph' and 'Triumph scion/V 135 stock' combinations would also not

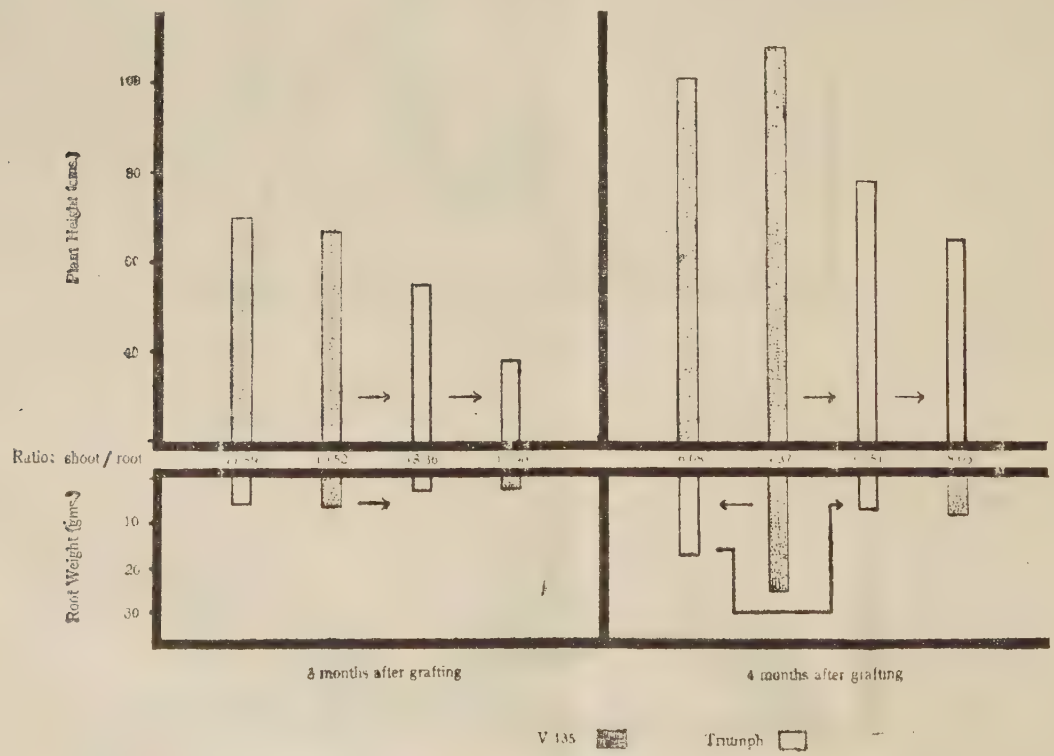



FIG. VII.—The effect of reciprocal grafting of Triumph and V 135 on plant height and root weight. Significant differences at 5 per cent. or less are indicated by arrows.

differ significantly. Actually the scion of the 'Triumph scion/V 135 stock' combination had not equalled that of the 'all Triumph' combination at the time of the second sampling, but the difference at the first sampling had been greatly reduced. At the first sampling the difference between the two scions was 16.9 cms. (36.5 per cent. of mean) as compared with a difference of 13.3 cms. (18.7 per cent. of mean) at the second sampling.

### Conclusions

The results of the small scale experiment suggest that the stock becomes adjusted to the requirements of the scion. Although only two varieties were examined it seems likely that the results may be fairly widely applied. General observations of an extremely wide range of cotton types reveal no permanent effect of stocks on the scions grafted upon them. An extreme example is provided by the fact that the tree cotton, *G. aridum*, which under Trinidad conditions reaches a height of 20 to 30 feet is not dwarfed on V 135 or N 14 stocks. But the transitory nature of stock effects does not mean that they are negligible. Figs. I to VI show that stock/scion adjustment may not be completed during the first season's growth, so that the vegetative vigour and yield of an annual variety may be considerably affected.

During the period of adjustment the habit of the grafted plant may be regarded as a compromise between the normal habits of the types providing stock and scion. Thus the characteristic rapid early growth and early fruiting habit of the Triumph and Gambia stocks was reflected by the scions grafted upon them. The V 135 and Jamaica Long Staple stocks exerted an opposite effect. The early retarding effect of the semi-perennial V 135 stock was partially compensated during the first season's growth by the fact that later it tended to maintain growth and extend the bolling period. The perennial Jamaica Long Staple stock was unable during a single season's growth to compensate in a like manner for its early retarding effect. Its year by year effect on a semi-perennial scion would be worth examination. An interesting aspect of stock/scion adjustment is that when the vigour of two varieties is determined by different limiting factors, the types obtained by reciprocal grafting may be superior to both the original varieties. A phenomenon which is analogous to hybrid vigour is therefore produced.

In addition to 'general habit' stock/scion adjustment, which was of major importance at high levels of stock vigour, there were indications of a second type of adjustment, *viz:* the preference of Asiatic scion for Asiatic stock and of New World scion for New World stock, which operated independently and which was manifested only at low levels of stock vigour.

Changes in scion yield corresponding with changes of stock are analogous to changes induced by varying levels of soil fertility. At the lower levels, replacement of one stock by a better one results in an all round increase of yield—both number of bolls and size of bolls are augmented. At the higher levels change of stock is accompanied by a re-adjustment of the yield components—boll number and boll size can no longer vary additively.

At first sight these results appear to be at variance with general grafting experience obtained with orchard crops. It has been well established that such crops show a marked and *prolonged* response of scion to stock. However, the present data show that, in cotton at any rate, the length of the period of stock/scion adjustment depends on the habits of the varieties grafted ; adjustment being considerably slower when perennial or semi-perennial varieties are involved. It seems possible that because of the highly perennial, arboreal habit of an orchard crop, its adjustment period may have an extremely long duration and, in fact, may not be completed during the economic life of the crop. It is interesting to note that results obtained from a long term experiment at Woburn (1898–1917) showed that differences in yield, induced by grafting scions of the same apple varieties on paradise and crab stocks, were progressively reduced and tended to disappear towards the close of the experiment. On the other hand at East Malling, apple varieties grafted on a larger range of stocks showed no marked tendency for stock effects to become uniform after a similar period of time (Hatton, 1935). Changes in relative stock effects were extraordinarily slow.

The data reported here, though limited, are sufficient to indicate clearly that more comprehensive experiments, carried out with suitable non-arboreal material, might be of value in elucidating certain general principles of stock/scion interaction which are not readily appreciable from direct studies of orchard crops.

I wish to thank Mr. J. B. Hutchinson, who suggested the experiment, for helpful discussion of the results, and Miss M. Smith for her careful preparation of the text figures.

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*See also* "Science and Fruit Growing" (1919) *Macmillan.*

# FURTHER NOTES ON THE FAUNA OF THE BRITISH SOLOMON ISLANDS

BY

R. J. A. W. LEVER, B.SC. (HONS.), D.I.C., A.I.C.T.A., F.L.S.

Since the publication of an article* on the fauna of the British Solomon Islands in 1937 (1), further determinations of the material collected there during a period of some five and a half years have been made, chiefly at the British Museum (Natural History). Most of the specimens were insects but identifications of other classes are also given in this article, which adds to our knowledge of the rich fauna of these Melanesian islands.

## MAMMALS

Besides the flying fox (*Pteropus scapulatus woodfordi* Thomas), there are several small bats including *Dobsonia inermis* K. Andersen, the very rare fruit-bat *Nesonycteris woodfordi* Thomas, the sheath-tailed *Emballonura nigrifrons solomonis* Thomas and the smaller, *Hipposideros cervinus* Gould, and greater horse-shoe bat, *H. calcaratus* Dobson.

Rats sent were similarly identified by Dr. E. Schwartz as *Rattus exulans* Peale, *R. concolor browni* and *R. alexandrinus*. The large indigenous rats belong to the genus *Cyromys*, not *Mus* as previously recorded (1).

## BIRDS

Of the seventy different species sent home none was new, but this was largely because so little collecting was done in the true jungle. The only island visited where the birds were unafraid of man was Sikaiana Atoll (Stewart Island), where a dark noddy (*Anous stolidus pileatus*) and a white tern (*Gygis alba candida*) allowed one to approach them very close when perched in trees despite their webbed feet. They were not seen on any other island and were new to some natives from Malaita, the nearest large island. The writer thinks that the percentage of Nematode and Cestode parasites from the eyes and intestines of local birds is high: these were collected only casually while the birds were being skinned. The black and white fly-catcher *Rhipidura leucophrys* is almost always infested with an undescribed bird-louse of the genus *Degeeriella*.

## AMPHIBIANS AND REPTILES

The tree frog *Hyla thesaurensis* Peters was taken in Bougainville Island (Mandated Territory of New Guinea) and is identical with specimens from the Protectorate. Eight species of geckoes were collected including *Gymnodactylus pelagicus* (Gérard), which extends to Tonga and Fiji, and *Lepidodactylus lugubris* (Dum. and Bibron) ranging through Fiji to Hawaii. Among the skinks, *Emoia* (6 species) and *Sphenomorphus* (4) are the commonest genera and show bifid tails after regeneration of the lost portion. Adamson (1a) is incorrect in giving *Crocodilus maximus* as the species of Crocodile, which is *C. porosus* Schneider.

## FISHES

Little work was done on the fishes but additions to those given before are *Opichthys* (snake eel), *Syngnathus spinifer* Ruppell (pipe fish), *Fistularia villosa* Kluzinger (shrimp fish), *Apogon orbiculariae* Cuv. & Val. (cardinal fish), *Hepsetia pinguis* Lacépède (sand smelt) and *Balistapus undulatus* Schneider (trigger fish). The author of the goby *Chorophorus ocellaris* is Broussonet and not Cuv. and Val. (1). Mr. J. R. Norman of the British Museum, who kindly identified these fishes, states that they filled several gaps in the national collection and more specimens from the Solomons would be welcome. Permission to use dynamite would have to be obtained in order to do extensive collecting in rivers or the sea.

## INSECTS

### Orthoptera

Starting with the stick-insects, Dr. K. Günther has described *Ophicrania leveri* on coconut leaves from Kolombangara Island in the West to Vanikoro in the Santa Cruz group in the east. The male measures 72 to 74 mm. in length and the female, which has fairly well-developed hind wings, is 102 to 107 mm. long. *Megacrania phelaus* Westw. was taken also on coconut leaves at Ugi Island while *M. alpheus* Westw. seems confined to *Pandanus* (screw pine, from Isabel to Vanikoro).

### Isoptera

Besides the termites previously dealt with, a recent determination is *Microtermes* (*Protocapritermes*) *trisiformis* Frogg. (new to the British Museum). For *Eutermes yandiniensis* Hill, the generic name *Nasutitermes* is preferable.

### Rhynchota

As in 1937 very little work has yet been done on the collection of Rhynchota although this order was well collected. Among the Aphids, *Toxoptera aurantii* Boyer, *Aphis laburni* Kalt on *Crotalaria* and *A. scabiosae* Schr. on tobacco have since been identified. Earlier references which were overlooked are the coconut Coccids *Trionymus malaitensis* Ckll., making covered runways on the fruit spathes, and *Neosimmondsia hirsuta* Laing. *Heterococcus painei* Laing (1) is invalid and should be *Phenacoccus horridus* Green. Four leaf-hoppers of the family Membracidae, all species of *Otinotoides* with a very pointed thorax, have been described by W. D. Funkhouser. Despite some work on Fulogoroidea by F. Muir shortly before his death, most of the extensive collections of Rhynchota are yet to be identified.

### Mallophaga

An addition to the Mallophaga or bird lice is an undescribed species of *Degeeriella* from the black and white fantail, *Rhipidura leucophrys melaleuca* (Quoy and Gaim.). Most of these birds from the grass plains of northern Guadalcanal have these parasites in their plumage.

### Lepidoptera

Attacks by *Rhipidura* on the Uraniid moth *Lyssidia achillaria* Hüb. have been described by Professor Hale Carpenter (2) from observations supplied by the writer on Tulagi. The latter is also indebted to Professor Carpenter for identification of seventeen species of *Euploea* collected from most islands in the Group. The chief points brought out from a distributional point of view are (i) the marked difference in species in the islands south-east of

* For maps of the Solomon Islands see page 282 of October 1937 issue of *Tropical Agriculture* (XIV, No. 10.)

Guadalcanal and Malaita, and the rest of the Group: thus San Cristobal, Three Sisters, Santa Ana and Santa Catalina have *E. brenchleyi*, *E. imitata* and *E. prusias* which were taken nowhere else in the Protectorate; (ii) the widespread range of *E. fraudulenta*, *E. polymela* and *E. treitschkei* from Shortlands in the west to Ulawa in the east, though the first was not taken on Malaita where *E. pyrgion* is dominant; and (iii) the not-unexpected differentiation in the easterly Santa Cruz islands where *E. melander*, *E. moesta* and *E. torvina* were the only species captured except for the widely-ranging *E. treitschkei*. *E. torvina* is known from New Caledonia and the adjacent Loyalty Islands, again showing that the fauna of Santa Cruz is more akin to that of islands to the south (1, p. 284). The brightly coloured Arctiid moth *Utetheisa*, a rare visitor in England, has been studied by Dr. Jordan who shews (3) that *U. lotrix stigmata* has the status of a sub-species in the Solomons, though not in New Guinea. Differences in neuration in the two forewings in the same individual is attributed to external factors upsetting the pupal equilibrium at a critical moment in its development. The absence of a tufted scent-organ on the hind wings of all specimens of male *U. salomonis* Roths. from the Solomons is interesting, as is the variation in length between the projections on the outer (wing) side of the antennae in the males sent from Guadalcanal and Gizo.

**Coleoptera**

The beetles have been most thoroughly described of all the insect orders but much yet remains to be done. The large red weevil which prefers ivory nut palm (*Metroxylon salomonense* Becc.) to the coconut has been shewn by Dr. Van Emden to be *Rhynchophorus bilineatus* Montr. and not *R. schach* Oliv. as mentioned previously. The latter with *R. papnanus* Kirsch seems confined to New Guinea and the Bismark Archipelago. A new *Diocalandra* which damages coconut flowers and young nuts on Malaita was referred to recently (4). In an interesting paper (4a), Sir Guy Marshall has described two subspecies, *kolombangarae* and *ganongae*, of the weevil *Exophthalmida coerulescens* Günther, which was described from Vella Lavella in 1937. A further interesting point is that on the larger islands of Guadalcanal, Isabel, Malaita and San Cristibal no specimens were taken either by the writer or by his industrious colleague Mr. H. T. Pagden. Among the Chrysomelidae, Mr. G. E. Bryant (5) has described five new species of Eumolpinae, one Galerucinae and four Halticinae, those of the first subfamily containing four species of the genus *Damelia*, of which *D. metallica* seems confined to Malaita and Ulawa. Among the Lamiidae (long-horned beetles) Dr. Breuning has described no less than 25 new species viz. 4 *Sybra*, 10 *Pterolophus* and 11 *Prosoplus*. A very interesting Anthribid is *Proscopus aper*, well figured in Dr. Jordan's paper (6) with its unusual bull-like horns above the mandibles; three other new species are therein described.

**Hymenoptera**

This large order has been less worked on than either the Coleoptera or Diptera and the H. T. Pagden collection of Aculeate Hymenoptera in the British Museum contains much new material, especially from the western Solomons.

An interesting insect is *Telenomus pontus* Nixon reared from an undetermined egg taken by the writer on Guadalcanal. Nixon's sketch (7) shews its torpedo-like shape; it is possibly dipterous though all recorded hosts of the genus are hemipterous or lepidopterous. Dr. Ferrière describes *Euplectomorpha salomonis* from a larval Zygaenid found on wild ginger on Guadalcanal by R. W. Paine. The bees have been well described by Professor Cockerel (8) who shews that the Andrenidae and Megachilidae are the chief families. In a later paper (1936), Cockerell says that a female *Lithurgus albofibriatus* Sichel, taken by the author on Sikaiana or Stewart Atoll in the same year, agrees with one from Tahiti. The range of *Megachile lachesis* Smith is extended from New Britain to Malaita Island and *M. shortlandi* Ckll. (not mentioned in Cockerell's 1911 paper) is the bee which eats out portions of *Cassia* and *Crotalaria* leaves for its nest. The writer's specimens taken in 1932 were from Guadalcanal, 300 miles south-east of the Shortland Islands. The brassy green *Halictus dampieri* Ckll., which frequents recently burst coconut inflorescences, is said by Cockerell to be common in Queensland from which it clearly reached the Solomons via New Guinea.

**Diptera**

It is fortunate that some systematics have been carried out on the flies, particularly by Mr. J. R. Malloch who has described (9) seven new species of *Homoneura*, Sapromyzidae), 6 new *Dacus* 16 other Trypetidae or fruit-flies and 14 Ortalidae including four new species of the unusually-shaped *Giraffomyia* with stalked eyes. Among the sandflies are *Culicoides orientalis* McFie (Russell Islands), *C. mollis* Edw., two new species of *Dasyhelea* (from Tulagi) and *Lasiohelea lefanui* Cart., besides *Styloconops albiventris* de Meij. mentioned before (1). Von N. Baranov of Jugoslavia has continued his work on the Tachinidae, describing new species among *Winthemia*, *Eutachina*, *Prosopodes*, *Actia*, *Phorocera*, two new genera, *Illa* and *Bezziomyiobia*, and a third species of *Chrysosarcophaga*. The parasitic Hippoboscidae comprise *Ornithoica pusilla* Schin., *Lynchia pollicipes* Ferris and *Ornitheza metallica* Schin. The Streblid *Nycteribosca minuta* Jobling, previously noted (1), is parasitic on Guadalcanal on the bat *Hipposideros cervinus* Gould (10) and *N. gigantea* Speis has since been recorded, probably from a species of *Dobsonia*, its host in New Britain. Among the spider-like Nycteribiidae are *Archinycteribia* (?) *actena* Speiser from *Dobsonia inermis* K. Anderson (Isabel Island), *Cyclopodia macrura* Speiser from the same bat on the same island, *C. minor* Speiser from *Pteropus* sp. (Russell Islands) and finally a species of *Nycteribia* (*Listropoda*), probably from *Miniopterus*, the host in the New Hebrides (10). Dipterists should beware of confusing the Tachnid *Leverella* with the Stratiomyid *Leveromyia*.

**Siphonaptera**

All the fleas submitted over five and a half years were from dogs and are *Ctenocaphalides felis* Bouché the so-called cat-flea and clearly a recent introduction

## MYRIAPODA

No identification has been received of the large gray millipede which reaches a length of about six inches and is common on tree trunks and on the ground in jungles. A short letter in "Nature" (10a) on the irritation caused by a secretion from the legs of a large centipede *Scolopendra* is of some interest as these Arthropods are generally believed to have all their poison contained in the fangs.

## CRUSTACEA

Further identifications by Dr. I. Gordon are *Euphausia*, a luminous shrimp from surf, collected at Santa Ana (Owaraka); the Stomatopod *Lyosquilla maculata* (F.) from Isabel; an Isopod *Exocorallana*

from a fish from Santa Ana and the well-known robber crab *Birgus latro* L., whose attempts to break open coconuts was observed by Guppy in 1883 at Malaupaina, Three Sisters. Such fresh water species as *Atya* and *Caridina* also occur and range as far as the Marqueses.

### MOLLUSCA

Mr. Crawford of the British Museum has identified *Succinea simplex* Pfr., *Trochomorpha* near *xiphias* Pfr., *Omphalotropis* sp. and *Partula* sp.

The shells of the pearly nautilus, *Nautilus pompilius* L., is used by the natives to inlay food bowls. Though somewhat primitive in finish it is pleasing to the eye and the craft may soon die out now that younger men can buy earthenware and enamel dishes.

### NEMATODA

Besides *Oxyspirura myzomelae* Baylis (described in 1935 from the red honey eater *Myzomela*) there is the Filariid *Aprocta rotundata* V. Linstow from the scrub pheasant, *Centropus albidiventris*, shot at Vella Lavella.

### POLYCHAETA

The well-known "palolo" worm, so often described from Fiji and Samoa, occurs and rises two days after the final full moon in October and November off the coast of Olawa Island, where its native name is "orku". Specimens sent to the writer by Mr. A. M. Andersen were identified by Mr. C. C. A. Munro as *Eunice viridis* Gray, the original palolo, all being in the sexual phase. Another kind sent was *Perinereis cultifera* Grube.

### OLIGOCHAETA

As my collections of these land worms were sent to Hamburg it is unlikely that they are now in a fit state of preservation: no identifications have been received.

### FLORA

The writer concentrated on the Pteridophytes which were examined by Mr. A. H. G. Alston (11) who finds their affinities entirely with New Guinea. Thus *Selaginella sepikensis* Hieron, described from the River Sepik, has been taken by the writer on Malaita 1,200 miles to the east; *S. nava* (Desv.) as far east as San Cristobal and *S. poperangensis* Hieron mentioned in the first paper (1). *S. rechingeii* Hieron is endemic to the Solomons from Bougainville to Santa Cruz and a new species, *S. leveriana* Alston, ranges from Tetipari to San Cristobal. The ivory nut palm *Metroxylon bougainvillense* Becc. of the Mandated Solomons may be a synonym of *M. salamonense* (Warb.) Becc.; further material is desired by Kew Gardens. A bracket fungus from Aru Islands, Shortlands was determined by the Economic Botanist, Kew as *Ganoderma lucidum*. The so-called "bushman's hair" is the mycelium of the horse-hair blight, a species closely related to the *Marasmius* which causes "witches broom" of cacao in tropical America and the West Indies.

### AGRICULTURE

Reference should be made to an article by Pagden (12) who deals with the copra industry of the Solomons which, until gold mining recently became important, was the only industry apart from timber. The value of copra exported in 1939 was £149,367, consisting of 21,944 tons. Now that copra has risen in price from £9 to £18 per ton and rubber from 7d. to 1/2 per lb., it is tragic that these products can no longer be exported from the Protectorate.

In the year 1940 two million super feet of timber, valued at £11,800, was exported and 220 tons of ivory nuts worth £900.

### GEOLOGY

In addition to the works mentioned in my paper referred to in (1) the following have since been identified by Mr. Campbell Smith: diorite, fine-grained tuff and altered basalt from Shortlands; horn blendic pyroxene andesite from Velle Lavella; porphyritic olivine basalt from Bava (Bagga) and basalt, besides limestones, from Maka, Malaita.

### RAINFALL

As indicated earlier (1, p. 284) the wettest months are usually January or February and the driest July to September, but in 1940 the position was reversed, August with 18.18 inches being the wettest and December with 3.75 inches, the driest month at Tulagi. During the last five years the seasonal index (ratio of rainfall in wettest month compared with driest) is 5.2 which compares well with 5.5 given before. It is regrettable that these records, begun in October, 1897, have now had to be discontinued after an unbroken run of nearly forty-five years. The rainfall for the last five years averaged 135 inches per year.

### CONCLUSION

When it is realised that new species of insects in the families Lycidae, Elateridae, Ortalidae, Ceratopogonidae and Tachinidae were described from specimens taken on the small island of Tulagi, which is but two miles long, it will be realised what an enormous field yet remains to be worked in the interior of the larger islands, one of which rises to over 8,000 feet. Tulagi, which has been the capital for fifty years, has Chinese market gardeners, extensive soil erosion, bush clearing, tree felling and a built-up area, so that much can be expected from the primitive jungles of Isabel, Guadalcanal, Malaita and San Cristobal, all of which are 75 miles in length and attain an altitude of over 3,000 feet. This paper, which is complementary to the first (1) gives some idea of what is known to exist and so should guide further collectors when this part of the Pacific is again available for research.

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## RUBBER PLANTS OF THE U.S.S.R. *

In 1931-1934 thirty expeditions were organized in the Soviet Union to search for rubber-containing plants. Over a thousand species were examined, and 609 were found to contain rubber or rubber-like substances. Only a few of these were considered suitable for cultivation, including guayule (*Parthenium argentatum*), eucommia (*Eucommia ulmoides*), some plants belonging to the Scorzonera (tausaghyz) and Taraxacum (kok-saghyz and krym-saghyz) genera, *Apocynum venetum* (*kendir*) and *Asclepias cornuti* (vatochnik).

By far the most important of these is kok-saghyz which is the only plant at present extensively used in the rubber industry. Tau-saghyz is the next most promising. Krym-saghyz yields a very high-quality rubber, but its cultivation has not so far been as successful as was anticipated. In the wild state kok-saghyz contains about 20 per cent., tau-saghyz about 40 per cent., krym-saghyz about six per cent. of rubber in their roots, the others up to about five per cent. in their leaves. In the cultivated state kok-saghyz roots contain about four to five per cent. of rubber in the first year of growth, 9 to 12 per cent. in the second year.

Kok-saghyz (*Taraxacum kok-saghyz*) is a perennial herbaceous plant found growing wild at altitudes from 2,000 to 2,300 meters on the headlands of Tian-Shan in Kazakhstan. It is very polymorphic, which explains its great adaptability to different soils and climates. It has been successfully grown on an experimental scale as far north as Archangel. The cultivated plant fructifies at the end of the first year of growth and may then be utilized for obtaining the rubber, which is localized in the roots in the form of long filaments.

In order to obtain the rubber from the roots of kok-saghyz, it is sufficient to reduce them to a fine powder which is macerated in water. The rubber separates out from the other matter by gravitation. The quality thus obtained, although inferior to the rubber obtained from *Hevea*, is quite satisfactory.

Tau-saghyz (*Scorzonera tau-saghyz*) is a small shrub having a flattened appearance and narrow rectilinear leaves. This plant was found growing wild on the Kara-Tau Mountains (Kazakhstan) at an altitude of 1,000 to 1,800 meters. The climate of these regions is excessively rigorous, the temperature ranging from —35°C. to + 40°C. The area under cultivation appears to be limited to the Kazakhstan territories. Tau-saghyz is less easy to acclimatize and cultivate and more susceptible to disease than kok-saghyz.

Krym-saghyz (*Taraxacum megaliarhizon*), a perennial herbaceous plant known as "mastikan", contains a very high-quality rubber, superior to that of *Hevea*, but the rubber content is only about six per cent. in the wild state and 0.7 to 0.8 per cent. when cultivated. It is also not entirely hardy. Experiments with its cultivation are still being continued.

Kendir (*Apocynum venetum*) is a perennial plant found growing wild on the banks of rivers in Northern Caucasus, Central Asia and Trans-caucasus. The plant is not exacting as regards soil and climate, but requires special care during the first two years (irrigation, weeding, protection against cold). It may be cultivated uninterruptedly over a period of about ten years. The stems are harvested twice a year, beginning in the third year: a normal harvest is 2 to 2½ tons per cutting or four to five tons per ha. a year. The rubber is localized in the leaves which may contain from 0.5 to 8.5 per cent. The woody parts of the stems may be utilized as construction and insulating material, and also for obtaining furfurol.

Vatochnik (*Asclepias cornuti*) was imported into the Ukraine from North America. Experiments have been started with a view to its utilization in the production of honey, paper and rubber. The rubber is localized in the tissues of the leaves and of the ovules in the proportion of two to ten per cent. The rubber is of rather mediocre quality owing to the high resin content.

Guayule (*Parthenium argentatum*) may be cultivated in arid subtropical and semi-desert regions. It is a perennial semi-shrubby plant of the family of Compositae. Most of the rubber is contained in the bark of the stems and roots, and may amount to nine to ten per cent. of the total mass of the plant.

Gutta is at present being extracted principally from naturally growing beresklet (*Euonymus verrucosus*). Recently, however, attempts have been made to cultivate *Eucommia ulmoides* Oliv., the gutta content of which is about three per cent. in the leaves, four to six per cent. in the stems, and 10 to 12 per cent. in the roots. Satisfactory methods of extracting gutta from the roots have not yet been devised, and at present only the leaves are used. Plantations are propagated by cuttings or rooted branches and come into economic bearing in four to five years.

Eucommia is a native of the moist sub-tropics. When grown in temperate regions it requires a deep, well cultivated, warm soil in a protected position. The chief difficulty in temperate culture is to provide sufficient moisture.

* Abstracted from *Soils and Fertilizers*, Vol. V, No. 2, 1942.

## NOTE

An extensive list of Institutions, Societies and Research Workers in the pure and applied plant sciences in Central and South America including the Caribbean Islands has been prepared by the Editors of *Chronica Botanica*, in cooperation with the Div. of Agriculture of the Office of the Coordinator of Inter-American Affairs Washington, D.C. It has been published in *Chronica Botanica*, Vol. VII, Nos. 2 and 3 (March, and May, 1942.)

## CHEMICAL NOTES

*(Compiled by the College Department of Chemistry and Soil Science)*

### A Rubber Substitute

One part castor oil to one part ethyl cellulose is the composition of the new plastic recently announced by the Hercules Powder Company to replace rubber in many of its uses. The new material has not the bounce of natural rubber, but there are many things for which rubber has been used which do not require this bounce—washers, gaskets, gloves, galoshes, garden hose, &c. It is estimated that sixty thousand pounds of rubber have been used in these ways annually, simply because it was cheap and plentiful. For all of them the new plastic is just as good, and in some ways better.—(*Science* Vol. 96, No. 2487, p. 11.)

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### Vitamins in Grass

This short article *published in Chemistry and Industry*, 61, 1942, pp. 255-6, is an abstract of a contribution to the symposium on green leaves as a source of protein and other nutrients arranged by the Nutrition Panel of the Food Group of the Society of Chemical Industry. The amount of the various vitamins available in a representative average of mixed grasses grown in Britain in June is tabulated in mg. vitamin per 100 g. together with the daily needs of an adult man and the amount in grams of grass necessary to supply each daily need. The figures are approximate. One to 2 kg. of fresh grass daily would be needed to supply the vitamin B complex, a quantity which it is felt even an enthusiast might have some difficulty in assimilating. Were grass processed along the lines described by Pirie* for the extraction of protein certain vitamins might be recovered as by-products. Ascorbic acid, in which grass is rich, could scarcely be successfully obtained because of its rapid oxidation under maceration and the fact that pre-treatments for the destruction of the oxidase would interfere with the recovery of the protein from the grass juice. Carotene could be recovered to a quarter of its total and might be used in colouring margarine, as a substitute for synthetic dyes of no nutritive value. At this rate of recovery 100,000 tons of grass would have provided enough carotene to add 0.6 mg. to each ounce of the present margarine ration during January February and March. Since carotene is absorbed into the digestive tract more easily from an oily substance than from green leaves the increased absorption would largely compensate for the low recovery of carotene from grass. The 0.6 mg. per oz. of carotene would colour margarine to match butter and would supply one-tenth to one-fifth of the daily requirement.—(*Horticultural Abstracts*: XII, No. 3, p. 171-172.)

* *Ibidem*, 1942, 61: 45-8.

### Quick Method of Making Humus

A system of composting is described in the *N. Z. J. Agric.*, 64, 125, whereby complete breakdown of material is achieved in a few weeks. The method differs from ordinary composting only in the introduction of air vents into the base of the heap. The humus-making plant described is an above-ground receptable of cement and boulders, 8 ft. by 3 ft. and 2 ft. 9 ins. deep, divided midway by a partition. At the bottom of each container a 12 inch square is dug and covered with heavy wire netting. Leading to the outside from each 12 inch square is a 9 inch pipe. The indraught of air through these pipes appears to stimulate the heating process. Larger pipes slow down combustion. Material placed in one container is turned into the other in 3 weeks and is ready for use in a month or 6 weeks later. Wood shavings and sawdust if used in small quantities, quickly disappear.

* * *

### Silage from (Sugar) Cane Tops

It is estimated that 6 million tons of harvested cane will yield 1½ million tons of tops. In making cane silage a pit 6 feet deep and 12 feet in diameter was filled with the tops up to 3 feet above the ground level and covered with 18 inches of soil. After 10 months the contents were readily fed to dairy stock. Green tops and ensilage obtained as described gave: moisture 76.10, 76.30; crude protein 1.80, 1.40; crude fat 0.30, 0.26; ash 3.10, 3.66; crude fibre 7.60, 8.55; carbohydrates 11.10. 9.86; CaO 0.15, 0.09 and $P_2O_5$ 0.12, 0.10 per cent. An even better silage would have been obtained if it had been mixed with green legumes.—(*Brit. Chem. and Phy. Abstracts*, B.III, 1942, p. 146, from paper by P. J. Skerman, *Cane Growers' Quart. Bull* (Queensland), 8, 124-125.)

* * *

### Conservation of Activity in Papain

A new process is mentioned in the *Bull. Imp. Trust*, 39: 372-3 whereby a product may be formed in which nearly all the original activity of the latex of the green fruit of *Carica papaya*, the papaw, may be retained for many months without apparent deterioration and the natural activator of the proteolytic enzymes, which occurs in the latex in considerable quantity remains in the papain. The process consists of adding common salt to the latex either before or after it has clotted, mixing thoroughly and partly drying the mixture, preferably in a vacuum and at a temperature not exceeding 55°C. With latex of average water content the amount of salt used may be about one-tenth the weight of the fresh latex. The evaporated product should be kept in airtight containers.